



NAVAL FACILITIES ENGINEERING SERVICE CENTER
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FLOOR COATING DEMONSTRATION: AIRCRAFT MAINTENANCE SHOP



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EXECUTIVE SUMMARY

This report was prepared to document the efforts of the Naval Facilities Engineering Service Center (NFESC) in demonstrating the application of a new floor coating specification designed for Aircraft Maintenance Shops. The demonstration was performed on the floor surface of a 1,700 ft² Electronic Equipment Maintenance Shop (Bldg. 1055) located at the Naval Air Station Joint Reserve Base (NAS JRB) Dallas – Fort Worth, Texas.

The coating specification, designed by NFESC and enclosed in Appendix A, is based upon a four-coat, thick film (1/4-inch), chemically resistant, interior flooring system with slip resistance. Within the report, photographs taken during the demonstration have captured the sequential application of the above coating system.

A combination of funding from NFESC's Demonstration/Validation program (DEMVAL) and NAS JRB was used to perform all work associated with this effort.

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INTRODUCTION

This report was prepared to document the efforts of the Naval Facilities Engineering Service Center (NFESC) in demonstrating the application of a new floor coating specification designed for Aircraft Maintenance Shops. The demonstration was performed on the floor surface of a 1,700 ft² Electronic Equipment Maintenance Shop (Bldg. 1055) located at the Naval Air Station Joint Reserve Base (NAS JRB) Dallas – Fort Worth, Texas. A combination of funding from NFESC's Demonstration/Validation program (DEMVAl) and the NAS JRB was used to perform all work associated with this effort.

CONDITION ASSESSMENT

Building 1055 has 1,700 ft² of floor surface covered with resilient tile. The concrete's surface has a cohesive strength of 200 psi (average concrete strength) with approximately a 1/16-inch deep layer of surface contamination. Two Moisture Vapor Emission Test Kits (MVETK) were used to determine an average moisture vapor transmission rate of 1.5 lbs moisture/1,000 ft² in 24 hours (results signifies dry concrete). The following chemicals are used in the maintenance shop: Coolant fluid (Mil-PRF-87252C), skydrol (hydraulic fluid), isopropyl alcohol, and various oils and greases. Within the maintenance shop and in adjacent rooms, tiles were disbonding as a result of spills from the above chemicals (chemicals penetrated through the base of concrete masonry unit walls and into adjacent rooms).

COATING SPECIFICATION

The coating specification, designed by NFESC and enclosed in Appendix A, consists of a four-coat, thick film (1/4-inch), highly chemical resistant, interior flooring system with slip resistance. The specification details the following: A) Contractor qualifications, B) Scheduling, C) Warranty, D) Material requirements, E) Material application (including surface preparation), and F) Quality control. Presented in the sections below are photographs, taken during the demonstration, of the sequential installation of the specified coating system.

SURFACE PREPARATION

TILE REMOVAL



Hand tool scraping.



Power tool chipping.

Floor coatings should never be applied over tiled surfaces. Tiled surfaces require complete removal prior to the application of floor coatings. Tiles were removed using a combination of hand and power tools.

REMOVAL OF TILE ADHESIVE AND DEGREASING



Black tile adhesive.



Tile adhesive removal using mechanical scrubbing and organic solvents.



Pressure rinsing.



Vacuuming up rinse water.



Resulting surface following degreasing.



Close-up of concrete after degreasing.

In order to develop sound adhesion between coating primers and concrete surfaces, surface contamination such as the above tile adhesive requires 100% removal. The tile adhesive was removed using mechanical scrubbing and organic solvents. A water-based caustic degreaser was used to remove concrete surface contamination (fuels, oils, skydrol) and residual organic solvent. Hot potable water under a pressure of 4,000 psi was employed to remove the caustic degreaser from concrete surfaces.

SHOT BLASTING



Shot blasting unit.



Two passes of shot blasting produced the above concrete profile (ICRI CSP 5).

Shot blasting removes weak surface cement (laitance), surface contamination, and opens up micro-pores within the concrete's surface. As such, shot blasting increases penetration and the resulting adhesion of coatings to concrete. Floor surfaces received two passes of shot blasting. The resulting surface profile was equivalent to the International Concrete Repair Institute's Concrete Surface Profile 5 (ICRI CSP 5).

POWER GRINDING



Power grinding the base of Concrete Masonry Unit (CMU) walls.



Resulting CMU profile from grinding (ICRI CSP 2).

In areas inaccessible to shot blasting, power tool grinding is used to prepare concrete surfaces. The following areas received power tool grinding: A) Floor surfaces at the base of walls, B) Four inches up the base of vertical walls, and C) Under secured equipment. Resulting surface profiles were equivalent to ICRI CSP 2.

KEYING SURFACES AND AESTHETICS



Keyed groove in area of heavy traffic.



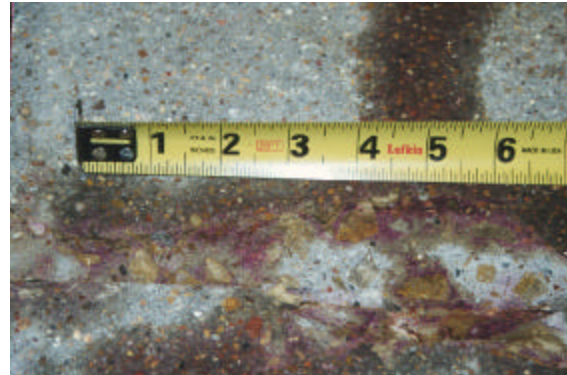
Cove strip installed for aesthetics.

Entrance and exit areas receiving high levels of traffic require a “keyed groove” to prevent thick film coating systems from disbonding which, if desired, enables coatings to be finished flush with adjacent surfaces. Keyed grooves were placed at the base of each doorway. The transition area between the coating system and wall surfaces may be aesthetically enhanced by the addition of a cove strip. Cove strips were installed four inches up the base of each perimeter wall.

DEGREASING FOLLOWING SHOT BLASTING



Shot blasted surface with skydrol saturated construction joint (Dark color).



Close-up of skydrol contaminated joint.



Shot blasted surface with oil contamination (Wet looking grid).



Commercially available portable adhesion testers: Dyna Tester and Elcometer™.

If following shot blasting, concrete surfaces appear either discolored or wet-looking when the concrete is dry, concrete requires additional degreasing. To quantify the degree of cleanliness, adhesion testing on contaminated surfaces may be performed using a portable adhesion tester. If adhesion results produce cohesive failures within the concrete (chunks of concrete attached to pull-off coupons), then concrete is sufficiently clean. If cohesive failures are not produced within the concrete and, in addition, adhesive values are below 200 psi, concrete requires additional degreasing. Three additional degreasing cycles were performed to remove surface contamination following shot blasting.

APPLICATION OF COATINGS

PRIMER AND INTERMEDIATE COAT APPLICATION



Squeegee application.



Roller application.



Screed application of intermediate coat.



Trowel application of intermediate coat.



Power trowel used to finish intermediate coat.



Cove trowel used to finish vertical walls.

Primers are applied by squeegee and roller, whereas sand filled intermediate coats are applied by screed and trowel application. The intermediate coat was finished using a combination of hand and power trowels. The resulting cured surface was sanded to enhance leveling and remove surface imperfections.

GROUT COAT AND TOPCOAT APPLICATION



Application of grout coat.



#60 mesh emery ore non-skid (aluminum oxide).



Application of topcoat.



The finished flooring system.

Applied to the intermediate coat to seal and subsequently fill surface voids is the grout coat. Once applied and cured, the grout coat may require sanding to further remove surface imperfection. Applied over the grout coat and with a broadcast of non-skid grit is the chemically resistant topcoat.

DISCUSSION

With an anticipated service life of 7 to 10 years, the coating system costs approximately \$6.00 to \$10.00 ft² installed. Up to two weeks maintenance shop down time is required for installation and curing prior to service. The coating system may be cleaned using a water-based pH neutral detergent followed by warm water rinsing. Floor cleaners containing either bleach or abrasive particles are not recommended.

ACKNOWLEDGEMENTS

For providing the demonstration site, the author wishes to thank LCDR Greg Simmons and Mr. Wes Cloud (NAS JRB). For his skillful degreasing technique and flawless application of the specified coating system, the author wishes to thank Mr. Craig Gruenler (Installation Contractor).

APPENDIX A

FLOOR COATING SPECIFICATION FOR INTERIOR AIRCRAFT MAINTENANCE SHOPS

PART 1 GENERAL

1.1 Background (Place condition assessment results here).

1.2 References

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM C 307 1994 Test Method for Tensile Strength of Chemical Resistant Mortars, Grouts, and Monolithic Surfacing
- ASTM C 579 1996 Test Method for Compressive Strength of Chemical Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
- ASTM D 412 1998 Test Method for Vulcanized Rubber and Thermoplastic Rubber and Thermoplastic Elastomers - Tension
- ASTM D 638 1996 Test Method for Tensile Properties of Plastics
- ASTM D 1308 1993 Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
- ASTM D 2240 1997 Test Method for Rubber Property-Durometer Hardness
- ASTM D 4541 1995 Test Method for the Pull-off Strength of Coatings Using Portable Adhesion Testers
- ASTM E 11 1995 Standard Specification for Wire Cloth and Sieves for Testing Purposes
- ASTM E 831 1993 Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis

FEDERAL STANDARDS

Federal Standard 595B: Colors

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1926.59 Hazard Communication

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

ICRI Technical Guideline No. 03732: "Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays".

1.3 Submittals

All submittals shall be submitted to the Government for approval and records.

- a. Two Component Epoxy Polyamine Primer
- b. Three Component Sand Filled Epoxy Grout
- c. Three Component Epoxy Polyamine Intermediate Coat
- d. Two Component Epoxy Novolac Topcoat
- e. White Aluminum Oxide Non-Skid Grit (#60)
- f. Degreaser(s)
- g. Material Certificates (Section 1.3.2)
- h. Contractor Qualifications (Section 1.3.3a)
- i. Coating System Performance (Section 1.3.3b)
- j. Procedural Variation(s) (Section 1.3.4)
- k. Scheduling (Section 1.3.5)
- l. Warranty (Section 1.3.6)
- m. Certified Coating Applicator (1.3.2f)

1.3.1 Instruction

For materials a. – f., submit formulator's printed instructions to include brand name, catalog numbers, and name of manufacturer. Include in the instructions (if applicable) date material was manufactured, shelf-life, detailed mixing and application procedures, quantity of material to be used on job, minimum and maximum application temperatures, and curing procedures. Include copies of Material Safety Data Sheets (MSDS) for all materials to be used at the job site. All coatings shall be manufactured by one coating vendor.

1.3.2 Certificates

- a. *Two Component Epoxy Polyamine Primer*
Submit certified conformance to the requirements set forth in Section 2.1.1.
- b. *Three Component Sand Filled Epoxy Grout*
Submit certified conformance to the requirements set forth in Section 2.2.1.
- c. *Three Component Sand Filled Epoxy Intermediate Coat*
Submit certified conformance to the requirements set forth in Section 2.3.1.
- d. *Two Component Epoxy Novolac Topcoat*
Submit certified conformance to the requirements set forth in Section 2.4.1.
- e. *White Aluminum Oxide Non-Skid Material*
Submit certified conformance to the requirements set forth in Section 2.5.1.
- f. *Certified Installation Contractor*

Installation contractor shall be certified by the coating manufacturer in the correct handling, mixing and application of their materials. Submit copy of certificates.

1.3.3 Statements

- a. Contractor Qualifications

Minimum requirements for installation contractor are as follows: Installation contractor shall have completed three or more jobs within the past two years applying the materials listed in Section 1.3.1 (a. – f.) exclusively to concrete surfaces in which the total area exceeds 100,000 square feet. Contractor shall submit documentation listing location of work, point of contact

at job site, total square footage of applied materials, listing of both materials and equipment used, and validation from coating manufacturer documenting quantity of materials purchased per job for work totaling 100,000 ft² and within the past two-years. Customers referenced by contractor shall be contacted by Government to confirm contractor's work is acceptable.

b. Coating System Performance

The manufacturer of the coating system shall submit literature documenting the past performance of the coating system's use in maintenance shops subjected to extreme chemical exposure. Minimum requirements are two or more maintenance shops totaling 34,000 ft² whereby the coating system has performed for two years with less than 1 % combined premature coating failures, material defects and surface discoloration (≤ 0.5 % discoloration due to aviation chemicals and tire plasticizers). In addition, coating system shall exhibit greater than 85 % non-skid grit retention within the above time frame. Coating manufacturer shall list location of maintenance shops, total coated area per shop, shop point of contact, date coating system was applied, and the names of the installed coating materials. Government shall contact each maintenance shop to confirm performance of coating system.

1.3.4 Work Procedure

Contractor shall submit all procedural variations different than those outlined in Part 3 titled Execution.

1.3.5 Scheduling

Contractor shall submit procedural scheduling, for Government approval, to complete work within twelve (12) consecutive days (weekends and evenings may be included). Contractor shall assign one supervisor to the job who is to remain on site throughout all phases of work who, in addition, is to act as the primary point of contact between Government and contractor. This person shall be identified in the submitted schedule. All work shall be performed in a manner as to cause the least interference with the normal functions of the Government activity.

1.3.6 Warranty: Installation and Materials

Materials and workmanship used to perform spall repairs and coating work shall be warranted by the "Installation Contractor" for a minimum of one-year following material application. Materials and workmanship shall be subjected to the terms and conditions defined as follows. The entire floor coating system shall be removed and replaced at the expense of the installation contractor (cost includes materials plus application) if ≥ 1.0 % of the total coated surface becomes either blistered (chemical), checked, soft, or lifts within one-year following application. Within the warranty period, failures greater than 3/8" diameter (of the above type) totaling less than 1.0 % of coated surfaces (including spall repairs) shall be identified and repaired at contractor's expense. Cosmetic imperfections due to scratching and gouging are excluded from the warranty. If the coating system's adhesion is in question, one adhesion test (ASTM-D-4541) shall be performed per 100 ft². Each adhesion test shall produce cohesive failures within the concrete above 200 psi with concrete chunks attached to each pull-off coupon. All areas tested for adhesion that do not produce cohesive failures within the concrete and, in addition, exhibit adhesion values below 200 psi shall require removal and replacement at installation contractor's expense.

1.4 Materials: Condition, Storage, Disposal

Materials on site shall be inspected for damage prior to use. Packaged materials in dented, rusty, or leaking containers and, in addition, materials with an expired shelf life shall be returned to manufacturer. Packaged materials shall be unloaded and stored out of sun and weather, preferably in air-conditioned spaces. All unused material, whether in its' cured or uncured state, shall be removed from the job site by contractor.

1.5 Safety

Throughout all phases of work, contractor shall follow the requirements of the Occupational Safety and Health Administration (OSHA), 29 CFR 1926.59, and safety procedures as recommended by the material manufacturers. Safety procedures may include employing the use of respirators, impervious clothing, gloves, face shields, and ear plugs. Prior to use and per material, contractor shall understand the information contained in Material Safety Data Sheets (MSDS).

1.6 Demonstration of Coating System

The following requirement applies to maintenance shops with concrete floors $\geq 5,000 \text{ ft}^2$. Prior to the coating system's approval, installation contractor shall apply the complete coating system to a ten-foot square section of concrete. Materials and procedures outlined in Parts 2 & 3, including a full broadcast of non-skid grit, shall be used in the application of the test patch. Six adhesion tests shall be performed 48 hours following the final topcoat application and in accordance to Section 4.1.1 (3 tests with coring and 3 tests without coring). The coating system shall be approved if the requirements of Sections 4.1.1 are satisfied. If concrete surface preparation was insufficient, contractor shall apply an additional coating system patch to properly prepared concrete followed by the above adhesion testing. If adhesion results are unacceptable for both the topcoat and the coatings below, contractor shall submit a new coating system manufactured by a different coating vendor. Prior to approval, a patch of the new coating system shall be applied and subjected to the above requirements for adhesion. Immediately following adhesion testing, patch shall be sanded flush with surrounding concrete.

PART 2 PRODUCTS

2.1 Two Component Epoxy Polyamine Primer

Two component, 100 % solids, epoxy polyamine concrete primer.

2.1.1 Epoxy Polyamine Grout Primer

The epoxy polyamine grout primer shall be formulated to exhibit the following properties as listed in Table 1.

Table 1: Properties of Epoxy Polyamine Grout Primer

Resin System	Epoxy Polyamine
Percent Volume Solids	100 %
Color	Clear to Amber

Application Thickness	5 to 30 mils Dry Film Thickness per coat
Chemical Resistance to JP-8 Fuel @ 70°F (ASTM-D-1308)	48 hours immersion ¹ : ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Motor Oils @ 70°F (ASTM-D-1308)	48 hours immersion ¹ : ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Skydrols @ 70°F (ASTM-D-1308)	48 hours immersion ¹ : ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Mean Coefficient of Thermal Expansion, 0°F – 120°F (ASTM-E-831)	3.0 – 60.0 x 10 ⁻⁶ in/in°F
Softening Point (ASTM-E-831)	≥ 175°F
Adhesion to Concrete (ASTM-D-4541)	≥ 400 psi

¹After immersion, the coating shall not contain blisters, checks, or lift from substrate.

2.2 Three Component Sand Filled Epoxy Grout

Three component, 100 % solids, sand filled epoxy grout for use in the repair of spalled/chipped concrete.

2.2.1 Sand Filled Epoxy Grout

The sand filled epoxy grout shall be formulated to exhibit the following properties as listed in Table 2.

Table 2: Properties of Sand Filled Epoxy Grout

Resin System	Epoxy Polyamine
Percent Volume Solids	100 %
Chemical Resistance to JP-8 Fuel @ 70°F (ASTM-D-1308)	48 hours immersion ¹ : ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Motor Oils @ 70°F (ASTM-D-1308)	48 hours immersion ¹ : ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Skydrols @ 70°F (ASTM-D-1308)	48 hours immersion ¹ : ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Compressive Strength (ASTM-C-579)	7,600 psi ± 1000 psi
Tensile Strength (ASTM-C-307)	1,800 psi ± 300 psi
Hardness (ASTM-D-2240: Shore D)	80 – 92
Mean Coefficient of Thermal Expansion, 0°F – 120°F (ASTM-E-831)	3.0 – 11.5 x 10 ⁻⁶ in/in°F
Adhesion to Concrete (ASTM-D-4541)	≥ 400 psi

¹After immersion, the grout shall not contain blisters, checks, or lift from substrate.

2.3 Three Component Sand Filled Epoxy Polyamine Intermediate Coat

Three component, 100 % solids, sand filled epoxy polyamine intermediate coat.

2.3.1 Intermediate Coat

The three component epoxy intermediate coat shall be formulated to exhibit the following properties as listed in Table 3.

Table 3: Properties of Sand Filled Epoxy Intermediate Coat

Resin System	Epoxy Polyamine
Percent Volume Solids	100 %
Color	Clear to Amber
Application Thickness	125 to 400 mils Dry Film Thickness per coat
Chemical Resistance to JP-8 Fuel @ 70°F (ASTM-D-1308)	48 hours immersion ¹ : ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Motor Oils @ 70°F (ASTM-D-1308)	48 hours immersion ¹ : ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Chemical Resistance to Skydrols @ 70°F (ASTM-D-1308)	48 hours immersion ¹ : ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness
Compressive Strength (ASTM-C-579)	7,600 psi ± 1000 psi
Tensile Strength (ASTM-C-307)	1,800 psi ± 300 psi
Hardness (ASTM-D-2240: Shore D)	80 – 92
Mean Coefficient of Thermal Expansion, 0°F – 120°F (ASTM-E-831)	3.0 – 11.5 x 10 ⁻⁶ in/in°F
Adhesion to Epoxy Polyamine (ASTM-D-4541)	≥ 400 psi
Adhesion to Concrete (ASTM-D-4541)	≥ 400 psi

¹After immersion, the coating shall not contain blisters, checks, or lift from substrate.

2.4 Two Component Epoxy Novolac Topcoat

Two component, 100 % solids, epoxy novolac topcoat formulated to increase chemical resistance.

2.4.1 Epoxy Novolac Topcoat

The epoxy novolac topcoat shall be formulated to exhibit the following properties and chemical resistance as listed in Table 4 and Table 5, respectively.

Table 4: Properties of Topcoat

Resin System	Epoxy Novolac
Percent Volume Solids	100 %
Color: Beige, Hi-gloss (Fed. Std. 595B)	13578, or 13690, or 13711, or 13740.
Specular gloss @ 60°	≥ 70
Application Thickness	2 to 20 mils Dry Film Thickness per coat
Service @ 48 hours cure, 65°F	Heavy Traffic, Full Chemical Resistance
Adhesion to Concrete (ASTM-D-4541)	≥ 400 psi
Adhesion to Epoxy Polyamine @ 48 hrs cure, 75°F	≥ 400 psi
Mean Coefficient of Thermal Expansion, 0°F – 120°F (ASTM-E-831)	3.0 – 60.0 x 10 ⁻⁶ in/in°F
Softening Point (ASTM-E-831)	≥ 175°F

Table 5: Chemical Resistance of Topcoat

<i>48 hours immersion @ 70°F (ASTM-D-1308)</i>	<i>Following immersion¹: ≤ 2.0 % increase in weight, ≤ 2.0 % increase in thickness</i>
Acetic Acid (50 %)	Pass
Acetone (10 %)	Pass
Aliphatic Naphtha	Pass
Ammonia	Pass
Ammonium Hydroxide	Pass
Aromatic Naphtha	Pass
Benzene	Pass
Bleach (5 %)	Pass
Brake Fluid	Pass
Butyl Acetate	Pass
Calcium Hypochlorite (5 %)	Pass
Cellosolve	Pass
Ethanol	Pass
Gasoline	Pass
Heptane	Pass
Hydrochloric Acid (37 %)	Pass
Isopropyl Alcohol	Pass
JP – 8	Pass
Mineral Oil	Pass
Methyl Ethyl Ketone (MEK)	Pass
Nitric Acid (25 %)	Pass
Phosphoric Acid (85 %)	Pass
Propylene Glycol	Pass
Skydrols	Pass
Sodium Hydroxide (50 %)	Pass
Sulfuric Acid (70 %)	Pass
Tetrachloroethylene	Pass
Turpentine	Pass
Toluol	Pass
Xylol	Pass

¹After immersion, the coating shall not contain blisters, checks, or lift from substrate. Slight staining is unacceptable.

2.5 White Aluminum Oxide Non-Skid Material

Dust free (washed and dry), white aluminum oxide non-skid material.

2.5.1 Aluminum Oxide

a. Size #60

Size #60 white aluminum oxide shall exhibit the following size gradations and formulation as listed in Table 6.

Table 6: Properties of White #60 Aluminum Oxide

Percent White Al ₂ O ₃	≥ 99 %
Sieve No. 40 (ASTM-E-11)	100 % Passing
Sieve No. 50 (ASTM-E-11)	20 – 30 % Retained
Sieve No. 60 (ASTM-E-11)	60 – 70 % Retained
Sieve No. 70 (ASTM-E-11)	0 – 10 % Retained

PART 3 EXECUTION

Notes A – E shall be treated as part of the specification.

NOTES A - E

Note A: Protection shall be provided by contractor to prevent damage to adjacent areas, equipment, fixtures, finishes, electrical utilities, mechanical services, and existing work. Damage to the above items while performing work shall be either repaired or replaced with new items at no additional cost to Government.

Note B: Care shall be taken to reduce the spread of dust and debris to office spaces adjacent the shop. Dust, waste, and debris resulting from work shall be cleaned and removed “daily” from the Activity.

Note C: Minor materials and work not specifically mentioned herein but necessary for the proper completion of the specified work shall be furnished without additional cost to Government.

Note D: Should deteriorated materials of a major nature be uncovered during the course of work, it shall be brought to the attention of the Contracting Officer. Repairs as directed by Government (in writing) shall be made with an adjustment, reflecting the terms of the modification(s), to contract price.

Note E: All work that is not performed in accordance to either the specification or manufacturer’s recommended procedures shall be replaced and reworked at contractor’s expense. If a dispute exists between specification and manufacturer’s procedures, the procedure which offers the greatest degree of prudence shall supercede.

“The following procedures are sequential and have been presented in the order in which the work shall proceed starting with Section 3.1.”

3.1 Removal of Material in Joints

Remove 100 % of the existing material in all expansion and contraction joints including material bonded to joint walls and base. Rigid material may require the use of saw cutting equipment to remove. Saw Cutting equipment shall be capable of producing straight lines with sporadic joint spalls less than 1/16". Joints may be widened by up to 1/8" when saw cutting.

3.2 Material Application

A minimum period of 36 hours following degreasing and 48 hours following heavy rain shall be used to allow concrete surfaces a chance to dry prior to the application of concrete repair material and coatings.

3.2.1 Temperature and Humidity Requirements

Coatings and repair material shall be applied when the relative humidity is below 80 % with temperatures between 55°F to 90°F (concrete and air). Temperatures shall also be a minimum of 5°F above the dew point temperature. If temperatures and relative humidity exceed the above ranges, work shall stop until either acceptable temperatures and relative humidity or material manufacturers approve application under existing conditions.

3.2.2 Mixing and Application of Materials

Mix and apply all materials in accordance to manufacturer's requirements. The use of spray equipment to apply materials is prohibited. Epoxy coatings, once mixed and prior to application, may require time to initiate their chemical reaction (induction period). It is recommended that representatives from the material manufacturers be on site to view both the mixing and application of their materials.

3.3 Remove Existing Coatings and Tiles

Remove 100 % of existing coatings and tiles employing a combination of one or more of the following techniques: shot blasting, chipping, scraping, sanding, light scarification, high pressure water blasting, and various hand tools. The use of impact tools (such as scabblers) may not be used to remove either coatings or tiles. Prior to blasting, old shot shall be removed and replaced with new shot. Shot blasting to remove existing coatings shall stop when the concrete's surface resembles an ICRI CSP 5 profile.

3.3.1 Remove Tile Adhesive

If tiles were previously installed, remove 100 % of the tile adhesive. Tiles adhesives may be removed using organic solvents followed by power scrubbing. Resulting surfaces shall appear visually clean with the gray color of concrete.

3.4 Spall Repair

Saw cut, in square to rectangular geometries, 0.5 – 2 inches away from the perimeter of each spall using a depth of 0.5 – 2.0 inches (depth is spall dependant). Concrete within the repair area shall be broken out using a chipping hammer and contain a minimum depth of 0.5 inch or until sound concrete is exposed. The repair cavity shall be inspected for unsound concrete by tapping with a hammer or steel rod. In areas where tapping indicates unsound concrete, additional concrete shall be removed. Resulting surfaces shall contain sound concrete, smooth vertical walls, and a repair base of uniform depth. Sweep and vacuum all dust from repair area.

3.4.1 Prime Repair Areas

Prime all concrete surfaces that are to receive the epoxy grout using the "Two Component Epoxy Polyamine Primer" specified in Section 2.1. Primer shall be applied at 10 mils wet. Prime saw cuts outside the repair geometry.

3.4.2 Epoxy Grout Application

Immediately following primer application, apply the epoxy grout specified in Section 2.2 directly into the wet primer per repair area. Fill and trowel in the epoxy grout into both the

concrete repair and the adjacent saw cuts. Epoxy grout shall be worked towards the perimeter of the patch to establish contact and enhance bonding to the existing slab. Make at least two passes with the trowel to ensure a smooth repair surface that is level with the surface of the floor slab. Resulting repair shall be dense, homogenous and finished to the same surface slope as the existing concrete slab. When cured, remove trowel marks and blend grout into adjacent concrete by sanding.

3.4.3 Grout Coat Application

Approximately 8 – 24 hours following application of epoxy grout, seal the surface of the repair by applying an additional coat of the primer specified in Section 2.1 at 10 mils wet.

3.5 Surface Preparation

3.5.1 Degrease Concrete

Degrease entire floor by scrubbing (manual and power) using a solution of hot potable water (120°F – 170°F) and a concentrated aqueous-based caustic degreaser (water-based alkaline degreaser). Solution shall be allowed to soak into surfaces prior to scrubbing and removed using hot potable water under a minimum of 4,000 psi pressure. Rinsing shall be complete when rinse water appears clear. Two complete degreasing cycles shall be performed on entire floor surface and one additional cycle of spot degreasing shall be performed on all areas that appear visually oily/greasy. If the industrial detergent is not biodegradable, all rinse water shall be collected and disposed of as hazardous waste. Use of industrial degreasers containing either phosphates or organic solvents is prohibited. Squeegees and shop vacuums may be used to collect pooling rinse water. Fans may be used to aid drying of floor surfaces.

3.5.2 Concrete Surface Preparation

Surface preparation techniques employing acid, organic solvents, extreme heat (flame), impact tools (scabblers) and scarification is prohibited. After degreasing and when concrete is dry, shot blast entire floor to produce a surface profile between ICRI CSP 3 and ICRI CSP 5 (excluding ICRI CSP 4). Shot blasting equipment shall produce a 20" minimum blast path width and, in addition, each pass shall be slightly overlapped (1/4" – 1/2" overlap). New shot shall be added to shot blasting equipment prior to blasting. Shot blasting shall stop when the concrete's surface resembles an ICRI CSP 5 profile. Concrete surfaces inaccessible to shot blasting (base of perimeter walls and under secured equipment) shall be prepared using diamond disk grinding to produce an ICRI CSP 2 profile. *If perimeter walls are constructed out of Concrete Masonry Units (CMU), surface preparation shall include preparing a minimum of 4" up the base of each interior perimeter wall to an ICRI CSP 2 profile.* Resulting surfaces shall appear visually clean and contain the appropriate level of surface profile. If the resulting level of cleanliness can not be determined, adhesion testing in accordance to ASTM-D-4541 shall be conducting on the dirtiest areas of concrete. Each adhesion test shall produce cohesive failures within the concrete above 200 psi with concrete chunks attached to each pull-off coupon. If the above adhesion results are not produced, then up to two additional degreasing cycles shall be performed using the materials and procedures outlined in Section 3.5.1. Sweep, vacuum, and run a high powered magnet over the above areas.

3.6 Key Entrances/Exits

Key all surfaces directly below doorways/exits. Resulting key shall contain one vertical wall at a depth between 3/8" to 5/8" with a 1.5" to 2" sloped surface leading down to the resulting

vertical depth. A hand held concrete saw may be used to cut the correct vertical depth followed by power tool grinding to attain the above sloped surface.

3.7 Install Bondbreaker Tape in Joints Greater Than 1/2" in Width

Apply solvent resistant bond breaker tape with an adhesive backing to the base of each joint $\geq 1/2$ " in width. Resulting tape application shall cover each joint's horizontal base and span its' total length. Application of tape prevents coating material from penetrating deep into joints and, in addition, prevents three-sided bonding of coatings to joint walls. Bond breaker tape shall contain a thickness less than or equal to 6 mils. Sand or backer rod is prohibited.

3.8 Install Cove Strip

A cove strip may be installed at a height of four inches up the base of each perimeter wall (CMU walls only). The cove strip shall be constructed out of solvent resistant plastic and installed using a solvent resistant adhesive (epoxy or polysulfide).

3.9 Application of Primer and Intermediate Coat (*Floor Surfaces*)

Sweep, vacuum, and run a high powered magnet over all areas that are to receive the coating system. The intermediate coat shall produce a monolithic flooring surface without exposed joints.

3.9.1 Primer Application (*Floor Surfaces*)

Apply a full coat of the epoxy primer specified in Section 2.1 at 10.0 mils wet. Primer is to be lightly applied into joints and without pooling. If either fisheyes or paint separations occur during the primer application, concrete contains hydrocarbon contamination (fuels, oils, skydrol) and requires additional degreasing in accordance to Section 3.5.1.

3.9.2 Intermediate Coat Application (*Floor Surfaces*)

Apply the intermediate coat specified in Section 2.3 directly into the wet primer at 250 mils wet. Fill each joint with the intermediate coat. The sand filled intermediate coat is best applied by screed application and finished using a steel power trowel. Directly above areas previously keyed and at a distance of 1.0" to 1.5" away from the coating's outer edge, slope the intermediate coating down and flush with the concrete's surface. The resulting angle shall terminate flush with vertical cut of the previously keyed groove. Perimeter edges and adjacent equipment footings may require finishing by steel hand trowel. When cured, sand entire floor surface. Resulting surface shall be monolithic, appear level, contain uniform thickness, and be free of surface imperfections including trowel marks.

3.9.3 Primer Application (*Up the Base of Perimeter Walls: CMU Walls Only*)

When the intermediate coat can be walked upon, prime approximately four inches up the base of perimeter walls to cove strip using the primer specified in Section 2.1 at 6 mils wet.

3.9.4 Intermediate Coat Application (*Up the Base of Perimeter Walls: CMU Walls Only*)

Apply the intermediate coat specified in Section 2.3 directly into the wet primer at 150 to 250 mils wet. A cove trowel shall be used to create a rounded transition between floor surfaces and the base of perimeter walls. When cured, sand the base and 4" up perimeter walls. Resulting finish shall contain a rounded transition of uniform thickness between floor surface

and vertical walls. Resulting surface shall be free of surface imperfections including trowel marks.

3.10 Application of Topcoats

Two coats of the epoxy novolac topcoat are to be applied. The first topcoat shall act as the grout coat whereas the second topcoat shall contain a broadcast of non-skid grit. White aluminum oxide non-skid shall be broadcast into the second topcoat at the Customer's desired rate as outlined in Section 3.10.1. If floor surfaces are to be exposed to either concentrated acids or concentrated bases, the specified non-skid grit may become chemically attacked and prematurely fail (consult coating vendor for an alternative non-skid grit).

3.10.1 Non-skid Grit

a. Light Broadcast of Non-skid Grit

Number 60 white aluminum oxide shall be broadcast at a rate of 1.0 lbs per 100 ft² into the second topcoat of epoxy novolac and backrolled. The floor shall be broken down into 600 ft² sections where 6 lbs of #60 non-skid grit is pre-weighed, placed into clean buckets and used in its entirety per marked 600 ft² section.

b. Medium Broadcast of Non-skid Grit

Number 60 white aluminum oxide shall be broadcast at a rate of 2.0 lbs per 100 ft² into the second topcoat of epoxy novolac and backrolled. The floor shall be broken down into 600 ft² sections where 12 lbs of #60 non-skid grit is pre-weighed, placed into clean buckets and used in its entirety per marked 600 ft² section.

c. Heavy Broadcast of Non-skid Grit

Number 60 white aluminum oxide shall be broadcast at a rate of 3.0 lbs per 100 ft² into the second topcoat of epoxy novolac and backrolled. The floor shall be broken down into 600 ft² sections where 18 lbs of #60 non-skid grit is pre-weighed, placed into clean buckets and used in its entirety per marked 600 ft² section.

3.10.2 Topcoat Applications

Resulting intermediate coat surfaces shall appear dull (sanded with visible scratches), smooth, and free of surface imperfections. Prior to topcoating, sweep and vacuum up residual dust and sand from intermediate coat sanding.

3.10.2.1 First Coat

Apply a full coat of the pigmented epoxy novolac topcoat specified in Section 2.4 at a spreading rate of 12.0 mils Dry Film Thickness (DFT). Stripe coat perimeter edges and around equipment footings. Apply topcoat up the base of CMU walls if applicable.

3.10.2.2 Second Coat

When the first coat of epoxy novolac is well within the coating manufacturer's recommended recoat window, apply a second topcoat of the pigmented epoxy novolac specified in Section 2.4 at a spreading rate of 5.0 mils DFT. Contractor shall monitor and report a minimum of

one WFT reading to Government per 600 ft² section of floor surface prior to broadcasting #60 grit. When the correct WFT has been applied per 600 ft² area, immediately and evenly broadcast the desired quantity of #60 white aluminum oxide grit into the second topcoat and backroll in two directions. *The coating system's adhesion shall be tested in accordance to Section 4.1.1.*

3.11 Curing

All materials shall cure in accordance to manufacturer's requirements. Improperly cured material shall be removed and reapplied by contractor at contractor's expense. It is recommended that a material representative(s) sign off on the contractor's finished product.

3.12 Final Cleanup

Following completion of work, remove debris, equipment, and materials from the site. Remove temporary connections to Government furnished water and electrical services. Restore existing facilities in and around the work areas to their original condition.

PART 4 QUALITY CONTROL

It is recommended that either a Navy Coating Specialist or a National Association of Corrosion Engineers (NACE) Certified Coating Inspector be on site prior to and during all coating operations. The Coating Inspector's role will be to enforce the specification by documenting and reporting on the quality of workmanship. Differences between coating specification and contractor's work shall be immediately reported to either Public Works or the Resident Officer In Charge of Construction. *Mixed material samples shall be taken during the application of each material and stored in labeled plastic containers.* Clean plastic bottle caps may be used for sampling materials. Fill one bottle cap per mixed material sample (liquid) to an approximate thickness of 1/8". If the coating system prematurely fails, the above samples will be used in the failure analysis.

4.1 Adhesion of Coating System

Either the Government or a third party coating inspector shall perform the below adhesion testing.

4.1.1 Adhesion of Topcoats/Intermediate Coat/Primer Coat

Forty-eight hours following the second topcoat application, two adhesion tests shall be performed on the coating system.

First Adhesion Test: Using a core drill and a 1" diameter core bit, the first adhesion test shall be performed by coring completely through the coating system and 1/4" into the concrete. Adhere a 3/4" pull-off coupon directly to the middle of the cored surface and perform the adhesion test in accordance to ASTM-D-4541. If the adhesion value is either ≥ 200 psi or produces a cohesive failure within the concrete (removal of concrete chunks), coating system's adhesion is acceptable. If the above requirements are not met, two additional adhesion tests shall be performed. If the above requirements remain unsatisfied, then one adhesion test per 100 ft² section shall be performed using the above procedures. Adhesion values per area shall meet the above requirements or coating system shall be 100 % removed to bare concrete and reapplied at contractor's expense. Contractor shall repair each area

tested for adhesion. Core holes shall be filled using the complete coating system. Resulting repairs shall be flush with adjacent coatings.

Second Adhesion Test: Without coring 100 % through the coating system and into concrete, the second adhesion test shall be performed on the topcoat. Score the circumference of the pull-off coupon and perform the adhesion test in accordance to ASTM-D-4541. The resulting adhesion value shall be ≥ 250 psi or additional adhesion testing shall be performed. Each topcoat adhesion value per 100 ft² below 250 psi shall require contractor to remove topcoats, re-sand intermediate coat, degrease entire floor (use a pH neutral degreaser with warm water followed by potable water rinsing), and re-apply the topcoats at contractor's expense. Contractor shall repaint the tested areas using the specified topcoat and #60 grit. Resulting repairs shall be flush with adjacent coatings. At a value of 300 psi, the adhesion pull test may stop. Remove pull-off coupon using a hammer and a quick horizontal blow to the pull-off coupon. If the adhesion test lifts the coating system from concrete, contractor shall remove the section of lifted coatings and repair resulting hole using the complete coating system.